

DOI: <https://doi.org/10.24297/jam.v21i.9187>**Problem oriented learning and teaching to improve the teaching quality of engineering mathematical analysis**

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Abstract

This paper objectively analyzes the challenges faced by the teaching of engineering mathematical analysis, analyzes the connotation and essence of problem-oriented learning and teaching, puts forward the problem-oriented learning and teaching mode, and tries to improve the teaching quality of engineering mathematical analysis.

Keywords: Problem-oriented learning; Mathematical analysis of engineering; Teaching quality.

1. Challenges in the teaching of engineering mathematical analysis

With the rapid development of science and technology, engineering mathematical analysis is closely related to the construction of new engineering. Through the establishment of appropriate mathematical models for social and natural phenomena and engineering technology, and then through analysis and calculation for quantitative analysis or qualitative analysis, we can get the explanation or solution of corresponding phenomena or problems. For the clear and thorough inference ability represented by mathematical thinking is an essential quality for doing any work well, engineering mathematical analysis has increasingly become a common language that must be mastered for learning every modern science and technology. Many domestic universities have been based on the needs of engineering development for mathematics and mathematics teaching and the progress of Engineering mathematics teaching reform, some engineering majors are offered "engineering mathematical analysis course". Taking Beijing University of Aeronautics and Astronautics as an example, engineering mathematical analysis has been taken as its six core basic courses [4]. At the same time, some engineering majors in Chinese universities have set up "engineering mathematical analysis" courses to replace the original "advanced mathematics" courses [6]. As an important basic course for many majors in science and engineering colleges, the main teaching goal of engineering mathematical analysis is to enable students to master the basic concepts, basic theories and common operation methods of calculus (including vector algebra and spatial analytic geometry), series and ordinary differential equations, and cultivate students' skilled operation ability, abstract analysis ability, logical thinking ability. In the process of learning the course of mathematical analysis, we should pay attention to the teaching mode of making students receive the preliminary training of mathematical analysis methods and using these methods to solve practical problems, so as to help students lay the foundation for the study of subsequent courses.

In a sense, mathematics quality reflects the cultural quality of modern high-level talents, so the theories and methods of engineering mathematics analysis are widely used to solve practical problems, which is also one of the main symbols to measure the educational effect of the course. Among the majors in engineering colleges, engineering mathematical analysis generally starts in the first year of the University. The main learners are the freshmen who have just stepped out of the middle school classroom and entered the university campus. Before entering the University, most of the students contact and learn elementary mathematical knowledge, while elementary mathematics basically does not involve movement and change. In the relationship of several relatively fixed quantities, we can find the unknown from the known. However, the basic viewpoint running through the whole higher mathematics is the viewpoint of movement and change [2]. To investigate problems from the viewpoint of movement and change and understand things from movement and change is the reflection of materialist dialectics in mathematics. The proper teachers' teaching methods have a positive impact on students' learning of engineering mathematical analysis. Therefore, it is necessary to study the teaching methods. We need to objectively evaluate the teaching methods, and continuously improve them according to the different times and environments.

The teaching of engineering mathematical analysis needs to pay attention to tradition. The teaching of engineering mathematical analysis basically focuses on the mathematics before the 19th century. Mathematics is a speculative science. The curriculum teaching of engineering mathematical analysis has its own particularity. It must be based on the mathematics learned in middle and primary schools and take the calculus founded by Newton and Leibniz as the main content, Its system and rigorous logical structure are established from bottom to top. Calculus is still the cornerstone of modern mathematics, and calculus is still widely used in the theories and methods of modern science and technology. It is a very important content in today's mathematics teaching. The teaching of engineering mathematical analysis also needs innovation and development. Innovation is the soul of a nation and the inexhaustible driving force for national prosperity. We must change the educational concepts and models that hinder students' innovative spirit and ability, especially teachers' one-way indoctrination of knowledge. Teachers need to strive to cultivate a group of academic leaders and top talents who can really stand at the forefront of Science and technology in the world. They also need to understand the importance and urgency of cultivating innovative talents from a strategic perspective. For a long time, our teaching of engineering mathematical analysis has placed too much emphasis on laying a solid foundation and teaching knowledge and skills, but ignored the cultivation of innovative spirit and innovative ability. At present, although we have a certain understanding of this problem and made some useful attempts, it is still far from the requirements of cultivating high-quality talents for mathematical literacy in the new century. The teaching reform of engineering mathematical analysis should adapt to the development of modern mathematics and the law of human cognition, especially the law of mathematics cognition and development. How to comply with the development requirements of the times, update the teaching ideas and concepts of engineering mathematical analysis, and strengthen the teaching of mathematical ideas and methods and the cultivation of innovation ability. It is a long-term and arduous task for every mathematics educator. For example, how to determine the appropriate teaching content according to the training objectives and teaching requirements and improve the teaching methods needs a long time of exploration and practice In particular, it is a very arduous task to systematically build the course of "engineering mathematical analysis", including the construction of characteristic teaching materials and teaching reference books, the construction of a high-level team of teachers engaged in both scientific research and teaching, and a good experimental teaching environment. However, the teaching reform is very important for improving the mathematical quality and innovation ability of engineering students [1][6].

2. Analysis on the connotation and essence of problem-oriented learning and teaching

Problem-oriented learning is a learning activity in which students, under the guidance of teachers, choose and determine research topics from students' life and social life, and actively acquire knowledge, apply knowledge and solve problems. The basic connotation of problem-based learning and teaching model includes the following contents. (I) Problem-oriented learning helps students return to the real world. Students live in the real world. In order to have an impact on students' life, education must pay attention to real life and make students have a strong sense of reality and life. Problem oriented learning aims at the disadvantages of the separation of traditional courses from students' life world, breaks through the constraints of discipline territory, and tries to return to students' life and experience. This return means that problem-oriented learning is a course of "in life, through life and for life". (II) The proble-oriented teaching model is based on students' experience. Problem-oriented learning goes beyond the curriculum form with cultural symbols as the pointer, and emphasizes the integration of curriculum resources with students' experience as the core; advocate relying on students' personal experience to obtain knowledge. Problem-oriented learning does not oppose direct experience and indirect experience. On the one hand, it respects the curriculum value of direct experience, on the other hand, it seeks the personal meaning of indirect experience, so that they can jointly construct individual and complete experience. (III) The problem-oriented learning and teaching model pays attention to students' active exploration and research. Autonomous inquiry is a basic learning method suitable for problem-oriented learning. The important purpose of problem-based learning is to change students' single knowledge acceptance learning mode and simple technical activity mode, so that students can learn through diversified inquiry activities such as investigation, experiment and physical labour practice. The problem-oriented learning is to find and solve problems in form, its essence is learning. Problem-oriented learning aims at the development of students' personality.

Since mathematics is a logical reasoning and thinking subject, its most attractive place lies in its thought. In the process of teaching, when teaching new concepts and knowledge, teachers should emphasize the source of these knowledge and how mathematicians find and solve problems. Mathematical analysis in engineering is to create an environment where students can think about the context of problems, motivate and promote students to solve some theoretical or practical problems by themselves. Some of these problems have no fixed methods, no designated reference books, or even formed mathematical problems, which mainly rely on students' independent thinking or group discussion, and let students study the ways to solve problems by themselves, and let students experience the process of finding and solving problems [7]. If you spend most of your time listing knowledge in the teaching process, as if the definitions and theorems are developed independently or in a vacuum, it is difficult for students to be interested in these knowledge. For example, why should we introduce the concept of uniform continuity of functions? Why should we introduce the concept of uniform convergence of function term series? In the process of teaching, teachers need to guide students to understand the essence of these problems. The function is uniformly continuous, which makes the calculation rigorous; the uniform convergence of function sequence is the premise that the algorithms of finite limit, derivation and integration are extended to infinite times. In the teaching process, it is necessary to emphasize the understanding of the essence of mathematical problems. The problem-oriented teaching mode is conducive to the cultivation of students' innovative ability, and this is actually the essence of the problem-oriented teaching model.

We emphasize the integration of teaching with life, the combination of theory and practice with practice, and the unity of scientific spirit and humanistic spirit. Teaching activities are realistic and rational activities; Teaching must keep a certain distance from the life of experience in order to be higher than life and create life; and teaching activities must also be based on epistemology. Therefore, we believe that problem driven learning is only a relatively new form of education and can not solve all educational problems. It has unique value, but there are also corresponding deficiencies: this model is conducive to cultivating students' desire for knowledge, but not conducive to the mastery of systematic knowledge. It emphasizes the educational value of the process of inquiry to students' development, but the operation is difficult and the supporting social environment needs to be improved; it meet students' interests and enthusiasm, but often make learning superficial and superficial, easy to connect with knowledge learning. It should also be emphasized that the root of problem-oriented learning lies in learning. Only the flexible use of problem-oriented learning and teaching can play a positive role in promoting our teaching and teaching reform.

3. Flexibly advocate problem-oriented learning and teaching mode and strive to improve teaching quality

1) Stimulating learning interest is an important means to improve teaching quality.

Mathematics is an important foundation of human civilization. Its emergence and development play an important role in promoting the process of human civilization. The promotion of the problem driven teaching mode of engineering mathematical analysis focuses on the problems before introducing knowledge and the interaction between teachers and students in the teaching process, so as to stimulate students' innovative thinking and creativity and improve teachers' own mathematical quality and innovative ability [5]. On the one hand, the course enriches and develops the existing teacher education and training model for mathematics teaching in engineering universities, which reflects the connotative development with teaching results, and has important theoretical value. On the other hand, the course constructs the exploration and inspiration mode of innovative mathematics teaching methods from the practical level, which makes the teaching of mathematics knowledge structure more, not limited to simple knowledge transmission, but more focused on the cultivation of innovative thinking, highlighting the sustainable development of educators in the new era, and has strong application value and practical significance; understanding these is helpful to improve students' interest in learning. From the connotation and representation of problem-oriented learning, we can see that learning interest is an important psychological factor in students' learning activities. Whether students are interested in learning, active or passive, the learning effect is very different. The urgency for students to pursue and explore knowledge is the internal driving force to learn engineering mathematical analysis well and overcome all difficulties, and it is the premise of thinking development. In order to make students learn well, we should first make students like learning. Albert Einstein said: "It is the supreme art of the teacher to awaken joy in creative

expressions and knowledge. Teaching should be such that what is offered is perceived as a valuable gift and not as a hard duty". We analyse the characteristics of each engineering specialty, establish the interface for engineering technology, open the channel between mathematical analysis and engineering technology, and explore the combination point of mathematical analysis and Engineering Science and technology. We Pay attention to strengthening the purposeful teaching of learning, and let students understand the wide application and profound cultural connotation of higher mathematics and its important role in learning subsequent courses, and make students consciously feel the importance of learning engineering mathematical analysis well. For example, let students to analyse the reasons for the changes of satellite cloud images in weather forecast, which can be attributed to the different distribution of air pressure in adjacent areas, and do discussion on the variation law of the value of the function $z = f(x, y)$ by considering the pressure distribution as a binary function from a mathematical point of view, and try to solve the following two questions:

- (1) How to describe the change of binary function in different directions;
- (2) Which direction is the fastest changing direction of the function.

We emphasize the application of mathematical thought in the field of engineering technology. In this process, students should be given gifts instead of burdens. Making students aware of the effectiveness of the course will greatly increase students' interest in learning. We pay attention to give full play to students' main role and subjective initiative in learning, and arouse students' urgent psychology of learning.

2) Innovating the content and structure system of teaching materials is the basic guarantee to improve teaching quality.

The innovation of teaching material content and structure system should reflect its rationality. Firstly, the teaching content should be reasonably planned. The teaching goal should be accurate and the requirements should be reasonable. Secondly, the concept definition should be accurate and the depth should be moderate. The teacher should pay attention to the basic points, key points, difficulties and methods. Thirdly, the teacher should pay attention to the renewal and expansion of content and the seamless connection of metabolism. The brief history and development trends of the discipline are introduced. Traditionally, the core content of engineering mathematical analysis teaching in some engineering colleges is from the simplification and modification of mathematical analysis teaching materials, so there are some problems. For example, the mathematical analysis teaching materials themselves do not pay attention to the practical application of calculus, which makes the introduction of the original teaching materials in the practical application of calculus insufficient; when simplifying and reducing the difficulty, the original textbook deleted the more difficult theoretical content for the teaching of non-mathematics majors. However, this goal led to the obscurity and incomprehension of the thought of calculus. Taking this as the starting point, a number of new teaching materials have appeared in the reform of the content and system of engineering mathematical analysis course in recent years. Its basic idea is to strengthen the penetration of modern mathematics, highlight the thinking methods of mathematics, optimize the teaching content and teaching strategies, integrate geometry and algebra, introduce modern teaching means, weaken calculation skills and emphasize mathematical application. "Engineering Mathematics Analysis Foundation" [3] edited by Professor Ma Zhien and Wang Miansen of Xi'an Jiaotong University, reconstructs the content system of traditional calculus textbooks, and strengthens the penetration of analytical thinking methods on the basis of highlighting the essence of calculus theory. , Making this set of textbooks the first choice for non-mathematics science and engineering high-level undergraduate talent training. The textbook won the first prize of the 2002 National Excellent Textbook for Colleges and Universities. Broadly speaking, it is the embodiment and improvement of problem-oriented learning in this theme and the innovation of teaching materials.

The traditional teaching method of engineering mathematics analysis emphasizes the aspect of teachers' imparting knowledge and ignores the aspect of students' learning process, thus ignoring the organic combination of imparting knowledge and ability training [6]. The teaching mode and methods of engineering mathematical analysis should be continuously improved in accordance with the requirements of the times. In order to cultivate students' autonomous learning ability and improve students' learning efficiency, we should enhance students' self-learning ability as a practical content. By making the rational use of multimedia as the

practical way of teaching reform and integrating the idea of mathematical modelling into teaching, students can comprehensively use their knowledge to solve social practical problems, and cultivate their innovation ability, which is an effective carrier to realize the combination of in class and out of class and the integration of theory with practice. Guiding and developing students' innovative thinking and potential with problems will be the core of teaching and teaching reform. Reproducing the thinking process of mathematical discovery, guiding students to gradually produce the smell of discovering problems, inspire students to use inductive and analogical thinking, encouraging students to reverse thinking. The cultivation of thinking ability is inseparable from the organic combination of traditional and modern teaching means and educational technology. The application of modern educational technology requires the rational use of video and animation technology, as well as the combination with traditional methods.

4. Conclusions

Modern scientific and technological innovation is developing rapidly at a higher speed, which requires everyone to uphold the attitude of lifelong learning and continuous improvement. Therefore, the problem-oriented learning and teaching model is also a part of the work of students and teachers in improving the learning process and teaching process. In the process of exploring the theory and method of problem solving, we should take problem traction as the main line to complete the problem-oriented teaching task by discussing and giving new concepts and calculation methods. In the whole teaching process, students study and discuss as explorers, and teachers participate in teaching as guides or collaborators. In the process of solving the problem, the students have experienced the process of understanding knowledge from fuzziness to clarity.

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